

Performance of a Compact, Portable, Stirling Cycle-Cooled High Purity Ge Gamma Ray Spectrometer Employing an Active Vibration Control

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We have developed portable high-resolution gamma ray spectrometers employing superlarge p-type coaxial Ge detectors (relative efficiencies better than 45%) and cryocooled with a compact, “free-piston” Stirling cycle units. In addition to an anti-microphonic mount of the crystal and passive and active counterbalance mass units implemented on the linear compressor of the cryocooler, we have integrated an electronic active vibration cancellation control system to further reduce the vibration generated by the cryocooler that causes poor energy resolution of the spectrometer. The electronic vibration cancellation system, which produces the drive signal for the cryocooler as well as regulates the cooler temperature, has been designed for minimum power consumption (preferably to run on DC batteries) and size. The power consumption for a 45%-relative efficiency Ge crystal at operating temperature is about 45 watts. Less than 100 watts are required for 4-6 hours at start-up to achieve an acceptable operating temperature of ~ 100 K for the detector. Field tests exhibit a degradation in energy resolution of only 25% or less (200 - 300 eV) for the ^{60}Co 1332 keV peak when compared to a liquid nitrogen-cooled Ge detector. The output pulse height stability is excellent between 77 and 100 K. Performance of the spectrometer during field applications in underwater and ship-board radionuclide monitoring is presented. Details of the design elements of the gamma ray spectrometer are discussed.

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